Committee on Resources,

Subcommittee on Fisheries Conservation, Wildlife & Oceans

fisheries - - Rep. Wayne Gilchrest, Chairman
U.S. House of Representatives, Washington, D.C. 20515-6232 - - (202) 226-0200

Witness Statement

Testimony of
Dr. Rita Colwell
Director
National Science Foundation
Before the House Committees on Resources and Science
Hearing on Ocean Exploration and Ocean Observations
July 12, 2001

Mr. Chairman, members of the Committee, I appreciate the opportunity to testify today on ocean exploration and ocean observations, activities in which the National Science Foundation plays an important role. These are areas in which many agencies, as well as the academic community and private sector, have a substantial interest and it is a pleasure to be here with Secretary Evans, Admiral Cohen, and Admiral Lautenbacher.

For generations, the search for knowledge and understanding of the oceans has captivated the human imagination. It will continue to do so for generations to come. But it is quite clear that our generation has a tremendous opportunity, and a keen responsibility, to fuel discovery in this realm. Technological and computational advances, as well as fundamental breakthroughs in understanding, are transforming the ocean sciences. At the same time, we are becoming increasingly aware of the economic, public health, and environmental significance of our oceans. Ocean exploration and the implementation of an integrated ocean observing system are two areas that can advance discovery.

EXPLORATION

NSF funds basic research and education in ocean sciences, and the facilities and instruments necessary to gain access to the oceans, from the surface to deep in the seafloor and from pole to pole. Exploration is a fundamental component of basic research. It is where science begins – with general ideas or broad hypotheses that seek to characterize new areas and processes in the ocean. The resulting knowledge provides a framework for further inquiry through subsequent, more specific investigations.

Last fall, the Panel on Ocean Exploration, chaired by Dr. Marcia McNutt, produced a report highlighting the fact that oceans remain largely unexplored and calling for establishment of an ocean exploration program. The report identifies many areas offering high potential for scientific advances. NSF is currently active in and seeks to expand activities associated with relatively unexplored areas and aspects of the oceans, incorporating both educational and data management and dissemination components, as well as technology development.

Let me highlight a few of the areas in which we see NSF playing an important role.

Relatively Unexplored Regions

- The deep biosphere (including the subsurface biosphere) found along seafloor volcanic ridges still remains a mystery. We are continuing to discover new hydrothermal vent locations, with their associated and remarkable ecosystems that may help to explain the origins of life on earth and open new avenues of research in biotechnology. These seafloor volcanic ridges and vents also help us develop an understanding of plate tectonics and how the earth itself was formed.

  A particularly compelling example of the kind of exploration activity the Panel has described is a recently completed expedition to the Indian Ocean. NSF funded an interdisciplinary team of 34 scientists, technicians and engineers to explore a newly discovered vent field by collecting biological samples and samples of vent and smoker fluid and plumes, rocks and sediment samples from the seafloor, and by precisely mapping the area. The research project is fully integrated with an educational component entitled "Dive and Discover", co-funded with Woods Hole Oceanographic Institution and Ohio's Center of Science and Industry, with live webcasts (through NASA), interactive opportunities between students and scientists, and companion materials that assist teachers in explaining the science and technology behind the cruise and in providing classroom activities. The "Dive and Discover" web site has been nominated for the "Webby Award" for its educational and scientific content.

  The ALVIN, in which I 've had the privilege of diving, has been an extraordinary tool for reaching the deep ocean over the past thirty years. A design study for an ALVIN replacement with even greater capabilities will start this summer.

- As noted by the Panel, both the Arctic and many areas of the Southern Ocean offer tremendous opportunities for exploration.

  - The Arctic is data-poor. It is difficult to reach much of the region, especially in the winter. NSF is presently developing robotic aerosondes, small pilotless planes, to sample the marine atmosphere and monitor sea ice. These planes can fly in hazardous conditions and over an extremely wide range – assets for obtaining measurements where manned missions would be costly and dangerous.

    We have also established an environmental observatory at the North Pole. This year we carried out a hydrographic survey from the North Pole toward Alaska. Automated instruments at the station transmit data by satellite from the ice surface and from instruments anchored to the sea floor.

    In cooperation with the Office of Naval Research and the Navy, we used Naval submarines to explore the Arctic Ocean from below and to chart the seafloor as part of our Scientific Ice Expeditions (SCICEX). With those submarines no longer available for scientific use, we are moving to a new way of exploring under the sea ice using Autonomous Underwater Vehicles (AUVs). They are designed to make long duration (11 day) forays under ice-covered oceans, and can transmit their position and data while underway.

  - The Southern Ocean – the southernmost reaches of the global oceans – is uniquely placed to contribute to understanding of many global environmental issues. In recent years it has been the site for regional global research programs, and more efforts are planned to understand the dynamics of Antarctic ocean circulation processes, the global dispersion of Antarctic water masses, and the region's contribution to the carbon cycle.

The cold temperatures, long periods of darkness, and episodes of high UV radiation place extreme stresses on biological systems in the Arctic and Southern Oceans. Scientists are discovering species of fish that have evolved specific genetic adaptations that enable them to live in freezing waters.

Exploring in Time

The Panel emphasized the need to explore ocean dynamics and interactions, often referred to as "exploring in time." Many of the most revealing discoveries today are coming from measurements made at the same location but over sustained time periods. NSF is vitally active in this area.

The availability of long time-series data that extend over several decades is recognized as a key element to understanding the role of the oceans in modulating the behavior of the earth system. For several years, we have supported time-series projects near Hawaii and Bermuda to enable understanding of processes that cannot be captured by snapshot visits. The data collected cuts across disciplines and sets the stage for further scientific inquiry.

We have also invested in technology development and emplacement of prototype seafloor observatories off of the New Jersey coast and Hawaii. Consistent with numerous recent reports, including one by the National Academy of Sciences highlighting both interdisciplinary research and educational benefits, NSF anticipates a growing investment in seafloor observatories. I will discuss this further in the context of the Integrated Ocean Observing System (IOOS).

Ocean Drilling Program

I would be remiss to discuss ocean exploration without mention of the Ocean Drilling Program, a longstanding program dedicated to ocean exploration and basic research which advances many areas highlighted by the Panel. The program is an international partnership involving over 20 nations with NSF providing about $50 million annually to support U.S. academic community involvement. It explores aspects of Earth's history, structure and processes by taking core samples of the Earth's crust from all of the world's oceans.

NSF has been working with its international partners to develop the Integrated Ocean Drilling Program (IODP), the future phase of scientific drilling. The Integrated Ocean Drilling Program, which will begin in 2004, envisions an ambitious expansion of exploration beneath the oceans, made possible by increasing drilling capability, from the single-ship operation currently in use, to a multiple-drilling platform operation of the future. The new drilling, sampling and observing capabilities will allow scientists to conduct experiments and collect samples in environments and at depths never before attempted. The IODP will recover cores from the deep biosphere and the subseafloor ocean and from as yet poorly sampled environments, such as the Arctic Ocean basin. The results assist efforts to "explore in time" by studying sediments which record historical changes in the Earth's environment.

Technology Development

Research in technology development, and subsequent capital investments in such technologies is critical to exploration as well as other areas of basic research. I have already mentioned many of these technologies, such as aerosondes, AUVs, under ice communications using mini-torpedos that heat their way through the ice and report by satellite, submersibles, and seafloor observatories, in the context of the science they support. Development of these important tools must proceed hand-in-hand with the development of scientific questions requiring their use.

One such technology development effort resulted in the Autonomous Benthic Explorer or "ABE." The concept of a roving robot that could remain on station in the deep sea for up to a year was developed in discussions between engineers and scientists studying hydrothermal systems. ABE is capable of performing detailed survey work with video cameras, sonar, and other sensors at pre-programmed areas and time periods. Between surveys, ABE remains parked on the seafloor awaiting the next pre-programmed survey, or a direct command to start a new survey. By being able to remain on the seafloor in an unattended mode over longtime periods, ABE allows us to study seafloor processes on space and time scales that we are unable to by using surface ships and manned submersibles alone.

While the kinds of technology I've just described are fundamental to exploration activities, their importance is by no means exclusive to them. In the remainder of my testimony I will discuss the Integrated Ocean Observing System, including coastal observatories, which will profoundly influence the conduct of basic research, exploration, and, for our sister agencies, operational activities.

COASTAL OBSERVATORIES AND INTEGRATED OCEAN OBSERVING SYSTEM

In establishing the National Oceanographic Partnership Program in 1997, the Congress found that "understanding of the oceans through basic and applied research is essential for using the oceans wisely and protecting their limited resources. Therefore the United States should maintain its world leadership in oceanography as one key to its competitive future."

A major focus of NOPP has been the development and implementation of a comprehensive, integrated national ocean observing system. NSF-supported researchers contribute to, and will benefit from, an ocean observing system in fundamental ways.

Design and Development

Effective and efficient oceanographic observation systems cannot be designed without some knowledge of the active processes that they are intended to study. Only with an understanding of the underlying processes can we make good decisions about what measurements will best characterize changes in the ocean, and, most importantly, how many measurements are required, and where they should be located. NSF-supported researchers contribute to an understanding of these processes and the intimate links that exist between the chemical, physical and biological variables.

Observational Activities in the Coastal and Open Ocean

In addition to the valuable operational uses of data made available through IOOS, access to long time-series data is imperative for basic research. The need is outlined in a variety of reports, the most recent of which is "Ocean Sciences at the New Millennium" published in April 2001. The report, developed by a committee of distinguished scientists with extensive community input, states that "*the lack of extensive, more-or-less continuous time-series measurements in the oceans is probably one of the most serious impediments to understanding of long-term trends and cyclic changes in the oceans and in global climate, as well as* *episodic events such as major earthquakes, volcanic eruptions or submarine landslides. We recommend strong support for the development, deployment and maintenance of long-term observing systems.*"

As part of its ongoing activities in both the coastal and open oceans, the Division of Ocean Sciences has been working with the academic community to develop an Ocean Observatories Initiative. The initiative is to provide basic infrastructure for a new way of gaining access to the oceans, by starting to build a network of ocean observatories that will facilitate the collection of long time-series data streams needed to understand the dynamics of biological, chemical, geological and physical processes. Just as NSF supports the academic research vessel fleet for the spatial exploration of our oceans, the system of observatories provided for by the Ocean Observatories Initiative will facilitate the 'temporal' exploration of our oceans. The Initiative entails implementation of a set of seafloor junction boxes connected to a series of cables running along the seafloor to individual instruments or instrument clusters. The junction box, with undersea connectors, provides a source of power to the instruments, and a means of transmitting two-way communications to and from the instruments. A data/operations center will be established that will function within the framework of the U.S. National Integrated Ocean Observing System (IOOS) and will be responsible for insuring unified data handling and dissemination procedures using the most advanced information and communications technologies.

The location and types of observatories to be established would be determined through a competitive peer review process. This new ability to continuously receive and record ocean data and to communicate with scientific instruments on the seafloor would greatly advance our knowledge and predictive capabilities in ocean science.

Data Collection, Management, Access, and Analysis

Advances in instant communication, vast databases, computational power, and extensive analytical capability contribute to making IOOS possible. One of the key components of IOOS will be a network for the system that links together various networks to form a "hub-node" system that is centrally managed.

NSF is providing support, along with its NOPP partners, for a consortium of private, academic, state, federal and international partners to plan and implement a network based system for the integration of regional, national and international oceanographic data.

In addition, NSF and the Office of Naval Research are sponsoring an Ocean Information Technology Infrastructure Steering Committee to develop a flexible and comprehensive implementation plan for a distributed information technology infrastructure that can be readily integrated with the "hub/node" enterprise.

Support for Management Structure

With its agency partners, NSF is currently supporting the recently established OCEAN.US office to coordinate implementation of IOOS.

CONCLUDING REMARKS

We are in a time of rich opportunity for research and exploration in oceanography. The advances that have been made are impressive. As new observation systems are implemented we will learn more about the changes that are occurring on our planet on time scales of days, years, decades and centuries. With the right investments the coming decades in ocean research and exploration will be truly extraordinary. NSF looks forward to working with other institutions, agencies, and nations to see that this happens.

Thank you again, Mr. Chairman, for the opportunity to share with you and the members of your committee the exciting work being supported and planned by NSF. I would be pleased to respond to any questions that you might have.

# # #